Main Features

- **High Sensitivity Full Frame CCD Sensor**
- **2048 x 2048 Resolution with 14 µm Square Pixels**
- **100% Aperture Pixels**
- **12-bit Dynamic Range**
- **Very Low Noise: 66 dB SNR**
- **Binning Modes**
- **LVDS Data Format**
- **High Data Rate: 20 Mpixels/s**
- **Flexible and Easy to Operate via RS-232 Control**
  - **Trigger Mode: Free Run or External Trigger Modes**
  - **Binning 2 x 2 and 4 x 4**
  - **Exposure Time**
  - **Gain: x1 to x8**
  - **3-Shot Color Operation**
- **Single Power Supply: DC 24V**
- **High Reliability – CE Compliant**
- **F (Nikon) Mount Adapter (Lens Not Supplied)**

Product Description

This camera is designed to meet high performance and quality requirements while providing ease of use.

- ATMEL manages the entire manufacturing process, from the sensor to the camera. The result is a camera that works in 12 bits, with dedicated electronics that provide an excellent signal to noise ratio.
- The sensitivity of the camera is fairly high even in the near infrared spectrum thanks to the 100% aperture pixel.
- The programmable settings let the user work at different integration times and gains. The external trigger enables synchronization of the camera on an external event, while the 3-shot color mode allows very high resolution for color image acquisition.

Applications

Performance and reliability of this camera make it well suited for the most demanding applications such as film and document scanning, semiconductor and PCB inspection, DNA analysis, metrology or X-ray imaging.

CAMELIA 4M

Full Frame Black and White and 3-Shot Color Digital Camera

Rev. 5301C–IMAGE–03/04

Camelia Package Contents

Depending on the selected configuration, a Camelia package may include:

- Camelia camera
- FGT frame grabber board
- Power supply cable and RS-232 cable
- Data and sync cable
- COMMCAM software
- FGT software
- Documentation

System Requirements

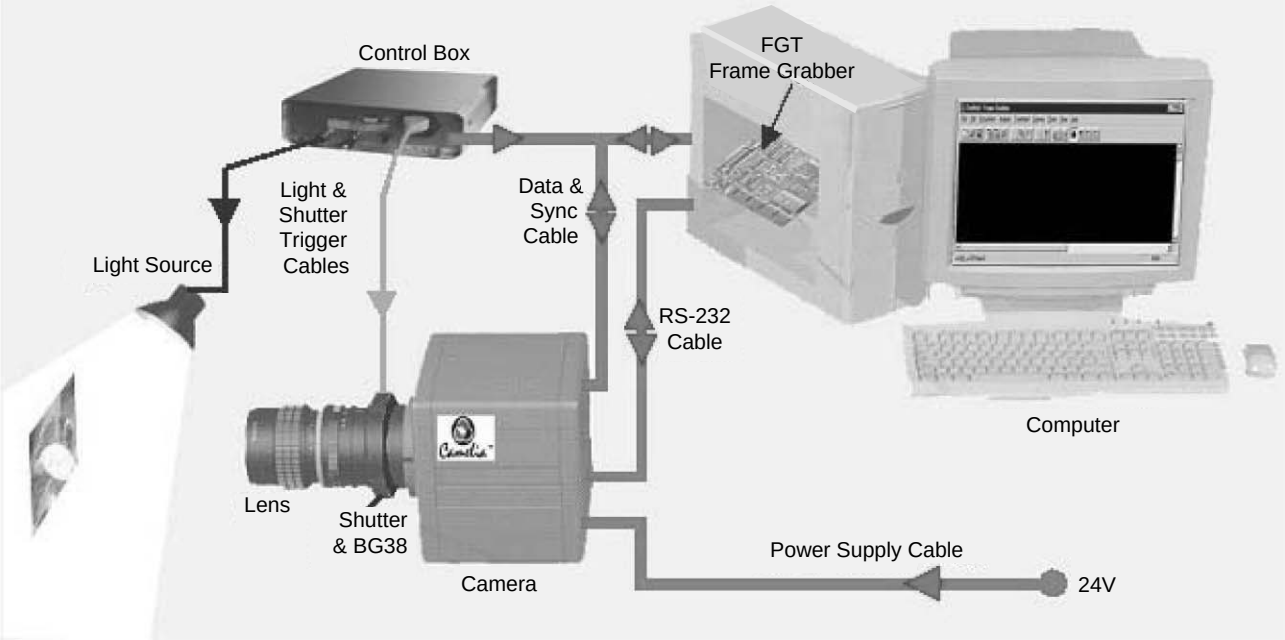
- 24V (0.6A) power supply
- Computer:
  - Minimal configuration:
    Intel® Pentium® II 350 MHz
    RAM: 128 Mb, 256 Mb for 3-shot color mode
    Cache memory: 256 Kb
    1 free PCI slot
  - Operating system:
    Windows® NT 4.0
    Windows® 95b, 98
- NIKON lens
- Lighting control (shutter/chopper or pulsed lighting)

Getting Started

1. Connect the camera to one of the computer's serial ports (COM1 or COM2) with the RS-232 cable.
2. Switch on the camera.
3. Install the COMMCAM software on your computer (refer to the "COMMCAM User Guide").
4. Install the FGT frame grabber board and the FGT software on your computer (see the "FGT Frame Grabber User Guide").
5. Run the system.

Description of Imaging System

Figure 1. Imaging System



The Camelia 4M is powered by a 24V power supply and is configured through the serial port of the computer. The camera sends digital video to the FGT frame grabber.

As the Camelia's CCD is a full frame sensor, either pulsed lighting or a chopper/shutter must be used in front of the camera during the integration time in order to obtain incident lighting on the CCD. The user must design an electro-optical interface to drive the camera, shutter/chopper or lighting by using the SHUTTER signal delivered by the camera. If required, the system can send an external trigger or external ITC (integration time control) signal to the camera.

Camelia 4M Camera

CCD Description

- Image format: 28.7 mm (V) x 28.7 mm (H)
- 2048 mm (V) x 2048 mm (H) active pixels
- Readout register along the small side of the image area (vertical image)
- Pixel geometry:
  - 14 µm (V) x 14 µm (H)
  - 100% aperture ratio
- Antiblooming by clocking

Timing

2 x 2 and 4 x 4 pixel binning can be used to enable previewing modes.

Data rate (pixel clock): 20 MHz

Table 1. Frame Readout Times

Mode	Frame Readout Times
No binning	235 ms
2 x 2 pixel binning	125 ms
4 x 4 pixel binning	70 ms

Three timing modes are available:

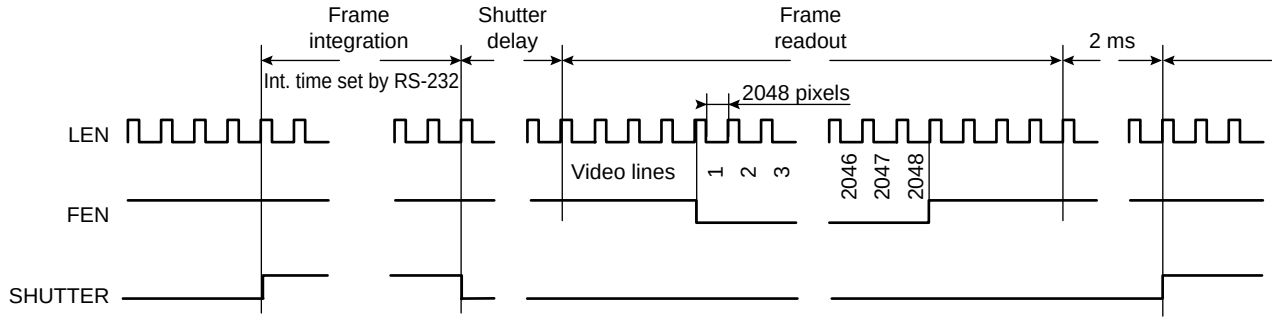
- Continuous
- External triggered
- Integration time controlled (ITC)

Continuous Timing Mode

The camera delivers frames continuously:

- Frame N+1 integration starts as soon as frame N readout is completed.
- The integration time is set by the RS-232 interface.

Figure 2. Continuous Timing Diagram

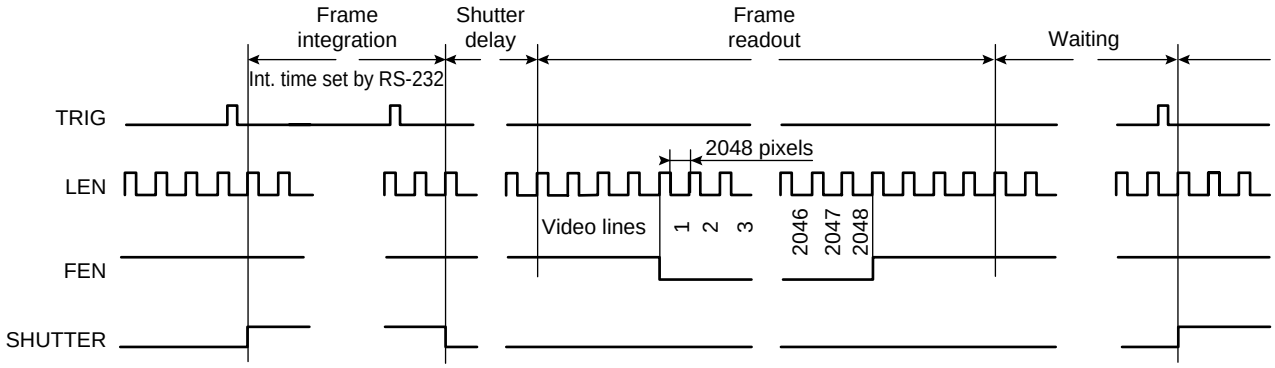


External Trigger Timing Mode

The external TRIG signal allows the user to control the start of frame integration:

- The rising edge of TRIG activates the start of frame integration. This rising edge is synchronized by the camera with a precision of 112 µs.
- The integration time is set by the RS-232 interface.
- Note that the TRIG signal period must be greater than the sum of the integration time and the frame readout time.

Figure 3. External Trigger Timing Diagram

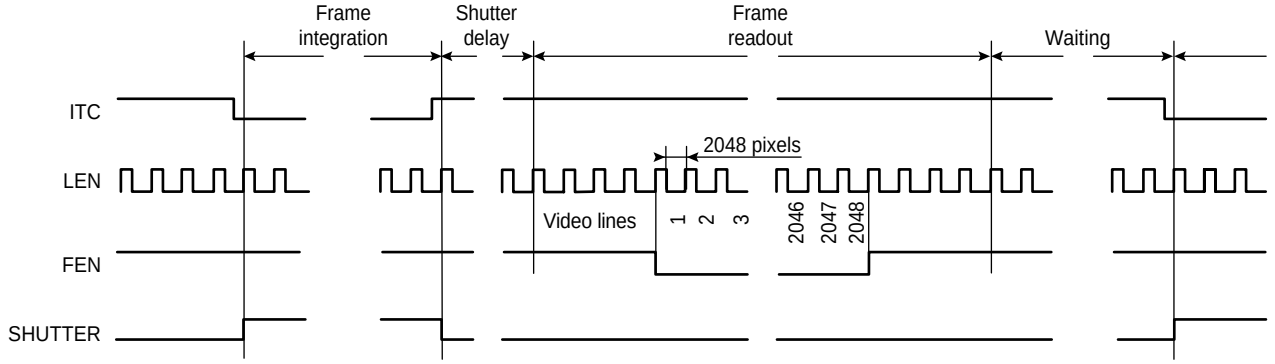


Integration Time Control (ITC) Timing Mode

The external ITC signal allows the user to fully control the frame integration:

- The falling edge of ITC activates the start of frame integration. This falling edge is synchronized by the camera with a precision of 112 µs.
- The rising edge of ITC activates the stop of frame integration. This rising edge is synchronized by the camera with a precision of 112 µs.
- Note that the ITC signal period must be greater than the sum of the integration time (defined by ITC low) and the frame readout time.

Figure 4. Integration Time Control Timing Diagram



Antiblooming by Clocking

Antiblooming can be activated or inhibited (see “RS-232 Interface” on page 8):

- Antiblooming OFF: antiblooming inhibited. Recommended if antiblooming is not required for the application.
- Antiblooming ON: antiblooming activated.

3-Shot Color Modes

In 3-shot color mode, each image is made of three frames: red, green and blue.

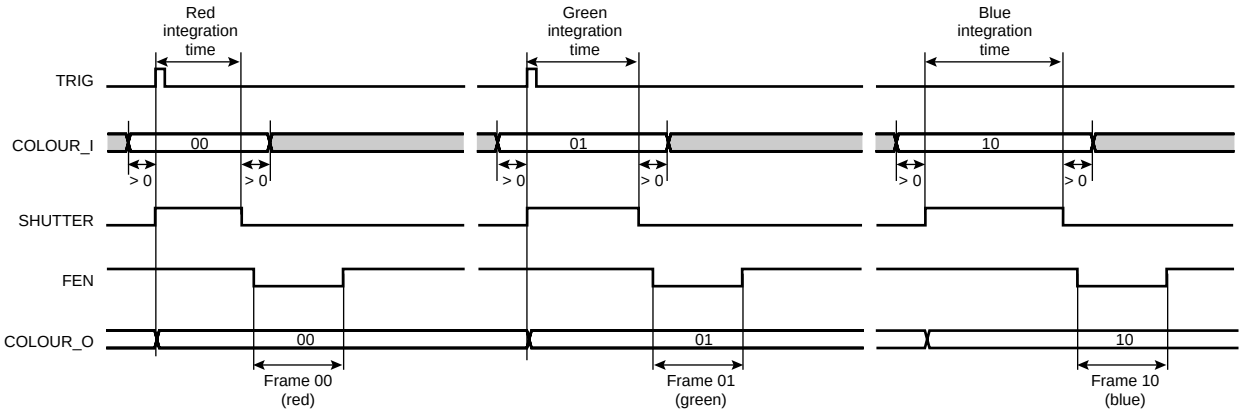
- The camera must be operated in either external trigger mode or integration time control mode.
- For each image, the user selects the color of the next frame by setting the input signals COLOUR_I1 and COLOUR_I2 (see Table 2). COLOUR_I1, _I2 must be valid between the rising edge of the TRIG signal (or the falling edge of the ITC signal) and the falling edge of the SHUTTER signal (see Figure 5).

Table 2. Color definition

COLOUR_I2	COLOUR_I1	Frame Color
0	0	Red
0	1	Green
1	0	Blue

- The integration time can be adjusted differently for each color, resulting in a better signal to noise ratio for the color with the lowest sensitivity (i.e the blue).
- Each frame requires a TRIG_ITC signal.
- The camera synchronizes COLOUR_I1, _I2 with the rest of the timing and sends COLOUR_O1, _O2 to the FGT frame grabber.

Figure 5. Color Timing Diagram



Electrical Interfaces

Power Supply

Table 3. Power Supply Specifications

Parameter	Nominal Value	Min Value	Max Value
Voltage	24V	20V	28V
Current	0.75A	N/A	N/A

Digital I/O

Table 4. Digital I/O Specifications

Symbol	I/O	Definition	Level
TRIG_ITC	I	Timing control: - TRIG_ITC is either an external trigger or ITC (integration time control) depending on the timing mode configured via RS-232. Operation with external trigger: - TRIG_ITC = TRIG Operation with ITC: - TRIG_ITC = ITC - TRIG_ITC is synchronized by the camera line clock (jitter: 112 µs)	LVDS(1)
S(11..0)	O	Digital video output: 12 bits	LVDS
FEN	O	Frame enable: - FEN = 0: frame data valid: active lines - FEN = 1: frame data not valid	LVDS
LEN	O	Line enable: - LEN = 0: line data valid: active pixels - LEN = 1: line data not valid	LVDS
PCK	O	Pixel clock	LVDS
SHUTTER	O	Shutter open/close: - during integration: SHUTTER = 1 - during readout: SHUTTER = 0 Delay between the falling edge of SHUTTER and the start of readout: - 4 positions: 1, 5, 10 or 20 ms (set via RS-232).	LVDS
COLOUR_I(1..0)	I	Color selection of the next frame (in color mode): - 00: red - 01: green - 10: blue	LVDS
COLOUR_O(1..0)	O	Color identification of the current frame (in color mode): - 00: red - 01: green - 10: blue.	LVDS

Note: 1. LVDS (Low Voltage Differential Signal) is an EI- 644 standard.

LVDS drivers/receivers:

- LVDS: all digital I/Os are differential: (signal+, signal-). Specifications are given for signal +.
- Manufacturer National Semiconductor®.
- Driver: DS90C031TM (SO16 package)
- Receiver: DS90C032TM (SO16 package).

RS-232 Interface

The camera's configuration is set by the RS-232 interface. Table 5 lists the available features:

Table 5. RS-232 Specifications

Function	RS-232 Configuration	Comment
Timing mode	3 modes: - continuous (free running) - external trigger - external ITC	
Binning	3 modes: - no binning - 2 x 2 pixel binning - 4 x 4 pixel binning	Image size: 2048 (H) x 2048 (V) Image size: 1024 (H) x 1024 (V) Image size: 512 (H) x 512 (V)
CDS gain(1)	2 positions: - G = 1 - G = 4	G = 4 is recommended for applications requiring high sensitivity
Camera gain(1)	Camera gain value from 1.00x to 2.00x in 16 steps	
Shutter	2 modes: - active - inactive (always open)	
Shutter delay	4 positions: - 1 ms - 5 ms - 10 ms - 20 ms	
Antiblooming control	2 modes: - active - inactive	
Black and white/ color mode	2 modes: - black and white - 3-shot color	
Black and white integration time	Value must be in milliseconds Range: 1 to 2000 ms; active only in black and white mode	Must be an integer (e.g. 120 for 120 ms, 120.4 is not permitted)
Red/Green/Blue integration time	Value must be in milliseconds Range: 1 to 2000 ms; active only in 3-shot color mode	Must be an integer (e.g. 120 for 120 ms, 120.4 is not permitted)

Note: 1. The video signal processing gain of the camera can be adjusted by setting either the CDS or camera gain.

CDS gain: a 1x or 4x gain is available at the input of the video signal processing. Use of the 4x gain is recommended for low level applications as it results in lower noise.

Camera gain: a range of 1x to 2x is available in 16 steps.

Electro-optical Performance

Conditions:

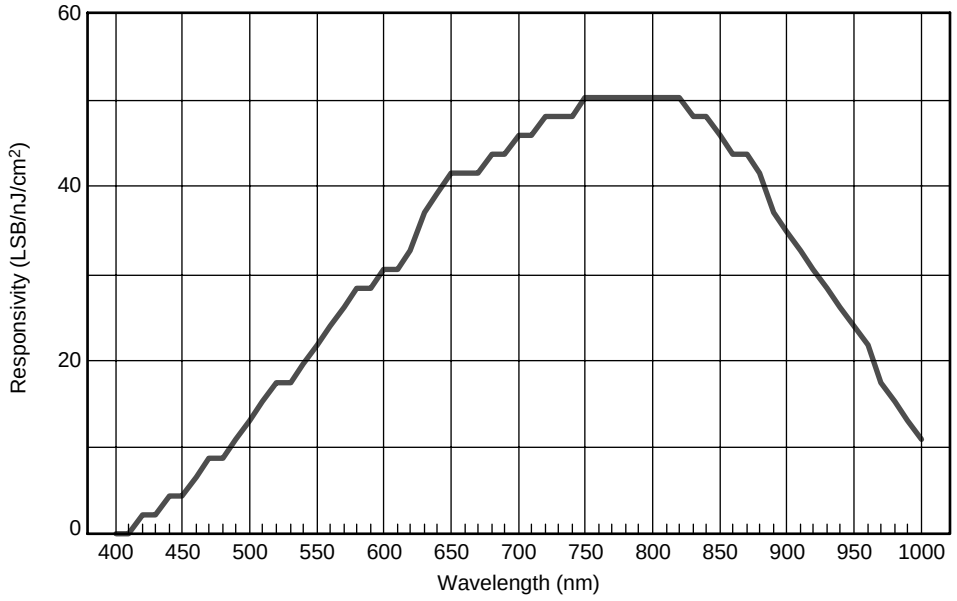
- Frame integration time: 40 ms
- Operating ambient temperature: 25° C

Table 6. Electro-optical Performance

Parameter	Symbol	Typical Value	Unit
Full-scale value(2)	VPE	4095	LSB(1)
Temporal noise(3)	VN	2	LSB
Dark signal non-uniformity(4)	DSNU	5	LSB
Dynamic range(5)	DY	2048	–
Responsivity(6)	R	35	LSB/(nJ/cm^2)
Resolution(7)			
Horizontal Contrast Transfer function at Nyquist	CTFh	40%	–
Vertical Contrast Transfer function at Nyquist	CTFv	40%	–

Notes:
1. LSB (Least Significant Bit): 12-bit = 4095 LSB or gray levels
2. Full-scale value VPE: maximum digital video signal
3. Temporal noise VN: r.m.s value in darkness; measured by subtracting two images pixel to pixel
4. Dark signal non uniformity: r.m.s value; excludes blemishes
5. Dynamic range DY = VPE/VN
6. Responsivity conditions: CDS gain = 1x, 3200K, light source powered between 300 and 1000 nm, measured on the sensor
7. Resolution conditions: light source 3200K, BG38 2 mm, measured at VIDEO = 2000 LSB, CDS gain = 1x

Figure 6. Camelia 4M Spectral Responsivity



Note: nJ/cm^2 measured on the CCD chip.

Image Grade

Operating conditions

- Room temperature: 20° C
- Integration time in darkness: 100 ms
- Light source: Halogen 3200K with BG38 (2 mm thick) IR cut-off with f/4 aperture
- Test under illumination at 50% saturation level

Definitions

A column defect is a one-pixel-wide column with more than 7 defective pixels. The column's height is constant with the light level.

Z1 is a square area whose size is 0.5 (H) x 0.5 (V) [1024 pixels (H), 1024 pixels (V)] centered in the image zone. Z2 corresponds to the rest of the image zone.

α is the contrast of the defect measured as a percentage under light and in ADU in darkness.

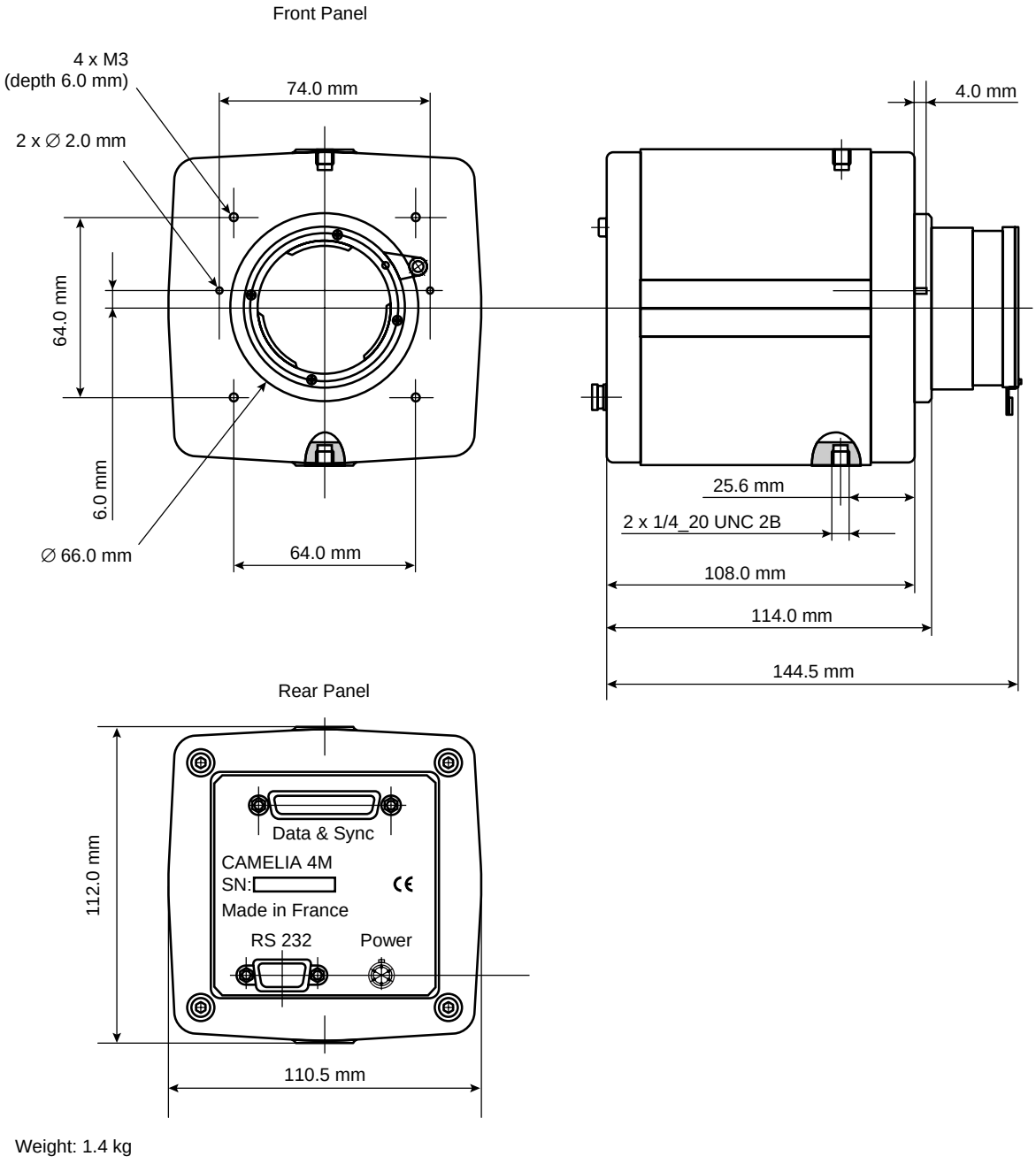
ADU: 12 bits correspond to 4096 ADUs.

Table 7. Specifications in Darkness

Type	Z1		Z1 + Z2	
	White defects in darkness	Defects at 50% VSAT	White defects in darkness	Defects at 50% VSAT
Blemish threshold	α > 80 ADU	[α] > 20%	α > 80 ADU	[α] > 20%
Maximum number of pixels affected by blemishes	600		2000	
Area maximum (in pixels)	5 x 5		5 x 5	
Column threshold	α > 5 ADU	[α] > 10%	α > 5 ADU	[α] > 10%
Maximum number of column defects	3	10	10	40

Geometrical Specifications

Figure 7. Camelia 4M Geometrical Specifications



Weight: 1.4 kg

Environmental Requirements

- Operating temperature: 0 to 50° C
- Storage temperature: -20 to 70° C
- Operating humidity: < 80% at 35° C
- Vibration: 2g sinusoidal, from 10 to 100 Hz

Connectors and Cables

Data and Sync Connector

50 points 3M connector:

- Connector reference: HIROSE DX10A-50S
- Mating connector on cable side: HIROSE DX40-50P; shell: HIROSE DX50-CV1

Table 8. Data and Sync Cable(3) Pinout

Pin Number	Signal	Pin Number	Signal
1	PCK+	26	LEN+
2	PCK-	27	LEN-
3	FEN+	28	COLOUR_O1+(1)
4	FEN-	29	COLOUR_O1-(1)
5	COLOUR_O2+(1)	30	GROUND
6	COLOUR_O2-(1)	31	GROUND
7	PDATA0+	32	PDATA1+
8	PDATA0-	33	PDATA1-
9	PDATA2+	34	PDATA3+
10	PDATA2-	35	PDATA3-
11	PDATA4+	36	PDATA5+
12	PDATA4-	37	PDATA5-
13	PDATA6+	38	PDATA7+
14	PDATA6-	39	PDATA7-
15	PDATA8+	40	PDATA9+
16	PDATA8-	41	PDATA9-
17	PDATA10+	42	PDATA11+
18	PDATA10-	43	PDATA11-
19	GROUND	44	NC(2)
20	GROUND	45	NC(2)
21	SHUTTER+	46	TRIG_ITC+
22	SHUTTER-	47	TRIG_ITC-
23	COLOUR_I1+(1)	48	COLOUR_I2+(1)
24	COLOUR_I1-(1)	49	COLOUR_I2-(1)
25	NC	50	NC

Notes:
1. Not used, must be left unconnected.
2. NC: not connected.
3. A Data and Sync cable is provided with the FGT frame grabber. It includes a part that connects to the electro-optical interface, and to the FGT frame grabber. Refer to the “FGT Frame Grabber User Manual”.

Power Supply Cable

Connector on supply side: SUBD9 male

Table 9. Pinout

Pin Number	Signal
1	24V
2	24V
3	NC
4	NC
5	NC
6	GROUND
7	GROUND
8	NC
9	NC

Note: NC: not connected

RS-232 Cable

Connector on computer side:

- DSUB9 female,
- Pinout compatible with a computer serial port.

The pinout is the same on both the camera and computer sides.

Atmel Corporation

2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 487-2600

Regional Headquarters

Europe
Atmel Sarl
Route des Arsenaux 41
Case Postale 80
CH-1705 Fribourg
Switzerland
Tel: (41) 26-426-5555
Fax: (41) 26-426-5500

Asia
Room 1219
Chinachem Golden Plaza
77 Mody Road Tsimshatsui
East Kowloon
Hong Kong
Tel: (852) 2721-9778
Fax: (852) 2722-1369

Japan
9F, Tonetsu Shinkawa Bldg.
1-24-8 Shinkawa
Chuo-ku, Tokyo 104-0033
Japan
Tel: (81) 3-3523-3551
Fax: (81) 3-3523-7581

Atmel Operations

Memory
2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 436-4314

Microcontrollers
2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 436-4314

La Chantrerie
BP 70602
44306 Nantes Cedex 3, France
Tel: (33) 2-40-18-18-18
Fax: (33) 2-40-18-19-60

ASIC/ASSP/Smart Cards
Zone Industrielle
13106 Rousset Cedex, France
Tel: (33) 4-42-53-60-00
Fax: (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906, USA
Tel: 1(719) 576-3300
Fax: 1(719) 540-1759

Scottish Enterprise Technology Park
Maxwell Building
East Kilbride G75 0QR, Scotland
Tel: (44) 1355-803-000
Fax: (44) 1355-242-743

RF/Automotive
Theresienstrasse 2
Postfach 3535
74025 Heilbronn, Germany
Tel: (49) 71-31-67-0
Fax: (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906, USA
Tel: 1(719) 576-3300
Fax: 1(719) 540-1759

Biometrics/Imaging/Hi-Rel MPU/
High Speed Converters/RF Datacom
Avenue de Rochepleine
BP 123
38521 Saint-Egreve Cedex, France
Tel: (33) 4-76-58-30-00
Fax: (33) 4-76-58-34-80

Literature Requests
www.atmel.com/literature

Disclaimer: Atmel Corporation makes no warranty for the use of its products, other than those expressly contained in the Company's standard warranty which is detailed in Atmel's Terms and Conditions located on the Company's web site. The Company assumes no responsibility for any errors which may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein. No licenses to patents or other intellectual property of Atmel are granted by the Company in connection with the sale of Atmel products, expressly or by implication. Atmel's products are not authorized for use as critical components in life support devices or systems.

© Atmel Corporation 2004. **All rights reserved.** Atmel® and combinations thereof, are the registered trademarks, and Camelia™ is the trademark of Atmel Corporation or its subsidiaries. Windows® is a registered trademark of Microsoft Corporation. Intel® and Pentium® are registered trademarks of Intel Corporation. National Semiconductor® is a registered trademark of National Semiconductor Corporation. Other terms and product names may be the trademarks of others.

Printed on recycled paper.

5301C–IMAGE–03/04 0M